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Impact of volatile composition on the sensorial attributes of dried paprikas

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ABSTRACT

Here we characterised the aroma of smoked, oven-dried, and sun-dried paprikas by sensorial evaluation and analysis of their volatile profiles. The sensorial panel defined smoked paprikas as having an intense, persistent, smoked odour and flavour and the highest acceptability. The oven-dried paprikas had a fruity odour and flavour related with aroma notes to fresh peppers. The sun-dried paprikas were associated with straw aromas and the worse valued. The chemical classes of volatile compounds also defined the paprika types. The smoked paprikas were richer in alcohols, phenols, pyrroles, and pyranones, whereas the oven-dried samples were characterised by their aldehydes and terpenes. The sun-dried paprikas had significantly lower amounts of odorant substances than the smoked and oven-dried paprikas. The intensity, persistence and smokiness descriptors (associated with smoked paprika) were positively associated with phenols and alcohols. Aldehydes were positively correlated with a fruity descriptor, which defined oven-dried paprikas, and negatively correlated with intensity, persistence, smokiness, toasted, and dried pepper descriptors. The descriptor straw, which defined sun-dried paprikas, was negatively correlated with alcohols, phenols, furans, and pyrroles.

1. Introduction

Paprika is widely used in the food industry as a natural colourant. Moreover, this spice is capable of modifying the flavour of food to which it is added, due to its characteristic taste and pungency, finding wide use in soups, sausages, cheeses, sauces and snacks (Nieto-Sandoval, Fernández-López, Almela, & Muñoz, 1999). Paprika is prepared by dehydration of some pepper fruit varieties (*Capsicum annuum* L.) and final milling of the dried pepper to obtain a fine powder.

Three types of paprika are traded in Spain and are mainly differentiated by their particular drying process. Heated, air-dried paprika is produced mainly in the south-east and middle-east of Spain, where the peppers undergo rapid dehydration under high-temperature conditions. Smoked paprika is obtained from the La Vera region, in the centre-west of Spain, where, in the traditionally and laborious drying process, oak logs are burnt to heat the paprika to 40 °C, giving the paprika a distinct smoked flavour. The sun-dried paprikas are imported from South America and South Africa. These various manufacturing methods confer remarkable colour and flavour characteristics to the final product (Velázquez et al., 2014).

Colour is the most studied parameter of marketed paprikas because, commercially, the red colour intensity is the main quality criterion. Although the colour intensity of the final product depends on the variety of pepper used (Deli, Molnár, Matus, & Tóth, 2001; Mínguez-Mosquera & Hornero-Méndez, 1993; Topuz, Feng, & Kushad, 2009), it is also highly influenced by the elaboration method (Mínguez-Mosquera & Hornero-Méndez, 1994).

Other aspects have also been studied as measures of paprika quality. Some works highlight the quality and quantity of aroma and flavour compounds of paprika as decisive parameters for quality control (Kocsis, Amtmann, Mednyánszky, & Korány, 2002; Korány & Amtmann, 1997). More than 125 volatile compounds have been identified (Nijssen, Visscher, Maarse, Willemsens, & Boelens, 1996) in fresh and processed paprika, although the significance of these compounds for the aroma is not yet well known (Pino, Sauri-Duch, & Marbot, 2006). 2-Isobutyl-3-methoxypyrazine and other alkyl-methoxypyrazines are characteristic compounds of the genus *Capsicum*. These volatile compounds, in addition to hexanal, hexanol, *cis*-2-hexanal and *cis*-2-hexenol, are the main compounds found in fresh pepper (Pino et al., 2006) and are responsible for the odour of freshly cut grass or ground leaves of green plant materials. The total amounts of volatile compounds have been shown to decrease during the maturation process (Pino et al.,

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2006). However, fruity attributes, represented by compounds such as 2,3-butanedione, 3-carene, trans-2-hexenal and linalool, increase during maturation (Mazida, Salleh, & Osman, 2005). The aroma constituents of dried peppers and paprika have been less studied. Such compounds were not detectable in the green bell aroma associated compounds after processing of peppers (Kocsis et al., 2002; Mateo, Aguirrezabal, Domínguez, & Zumalacárregui, 1997). Kocsis et al. (2002) reported that terpenes, sesquiterpenes, and terpene derivatives are more abundant in pungent paprikas than sweet ones. In smoked paprika, 95 volatile compounds were detected and acetic acid, 1,3- and 2,3-butanediol, and acetoine were identified as the major components (Mateo et al., 1997; Vidal-Aragón, Sabio, Lozano, & Montero de Espinosa, 1998). Various aspects are involved in the volatile profile of dried pepper and paprika samples as varieties of pepper (Ziino, Condurso, Romeo, Tripodi, & Verzera, 2009), ripening stage (Luning, Rijk, Wichers, & Roozen, 1994) and type of process (Velázquez et al., 2014) among others.

Although the volatile profile of paprika samples is established, its impact on the sensory perception remains unknown (Kocsis et al., 2002; Luning et al., 1994). Some studies have investigated the correlation between sensorial analysis and volatile composition of fresh pepper (Chitwood, Pangborn, & Jennings, 1983; van Ruth & Roozen, 1994), while Toontom, Meenune, Posri, and Lertsiri (2012) studied the correlation between volatile composition and sensorial attributes in chilli, dried by various methods.

Here we investigated the influence of the volatile profiles on the late sensory characteristics of paprikas, prepared by various drying methods (smoked, sun-dried and oven-dried), found in the Spanish market.

2. Material and methods

2.1. Sample collection

A total of three batches of paprika (*Capsicum annuum* L.) were examined in the present work. The smoked batch consisted of eight samples acquired from industries subject to Protected Designation of Origen "Pimentón de la Vera". The second batch included eight oven-dried paprikas bought from local markets. The third batch included eight sun-dried paprikas, imported from South Africa and South America. All samples (smoked, oven-dried, and sun-dried paprikas) were purchased packaged in cans. Moreover, all samples were purchased inside shelf-life of each product and with less than one year from the beginning of commercialization.

2.2. Volatile compound analysis

2.2.1. Volatile compound extraction

Three independent replicates, per 0.5 g sample, were weighed into a 5-mL headspace (Hewlett-Packard, Palo Alto, CA), containing dodecane as the internal standard, and sealed with a polytetrafluoroethylene (PTFE) butyl septum (Perkin-Elmer, Foster City, CA) and aluminium cap. Volatile compounds were extracted by solid-phase microextraction (SPME) (Serradilla et al., 2010) with a 10-mm long, 75-μm thick fibre coated with carboxen/polydimethylsiloxane (Supelco, Bellefonte, PA). Before collection of volatiles, the fibre was preconditioned at 220 °C for 50 min at the GC injection port. It was then inserted into the headspace vial at 40 °C for 30 min in a water bath. Blank runs were performed to discard possible volatile contamination during the volatile compound analysis.

2.2.2. Gas chromatography/mass spectrometry (GC/MS)

GC/MS analyses were performed as described by Serradilla et al. (2010), using an Agilent 6890 GC-5973 MS system (Agilent Technologies, Little Falls, DE) equipped with a 5% phenyl-95% polydimethylsiloxane column (30 m × 0.32 mm inner diameter, 1.05 μm film thickness, Hewlett-Packard). The Kovats index of the compounds was calculated by analysis of n-alkanes (R-8769, Sigma Chemical Co., St. Louis, MO) run under the same conditions as the samples. The NIST/EPA/NIH mass spectrum library (comparison quality > 90%) and Kovats index were used to identify the volatile compounds (Kondjoyan & Berdagué, 1996). Additionally, the identity of certain compounds was confirmed by a comparison of the retention time and mass spectra, using a laboratory-built MS spectral database, obtained from chromatographic runs of pure compounds performed with the same equipment and under the same conditions. Quantitative data were obtained from the total ion current chromatograms by integration of the GC peak areas.

2.3. Sensorial analysis

The panel of judges consisted of 15 trained members (eight females and seven males) of the Animal Production and Food Science Department (Agricultural Engineering School, University of Extremadura). All of the participants had previous experience and training (ISO, 1993, and UNE-EN ISO, 2009) in descriptive analysis studies (Ruiz-Moyano et al., 2011; Serradilla et al., 2010).

To familiarise the panellists with the sensory properties of paprika, two samples of each batch were used for the training in four sessions of 2 h each. During the first two sessions, the panellists interacted and discussed, to generate the terms that could describe the sensory characteristics of paprika samples. Finally, by consensus, the panel leader and panellists selected the attributes that best characterised the sensory characteristic of the paprika types (Table 1). The terms should be relevant to the product and cognitive clarity. The last two sessions of training were used to evaluate each term. In those sessions, physical references were presented to establish a scale for each term, ranging from 1 (very slight perception) to 10 (intense perception).

Twelve parameters that were mainly related to odour and flavour were assessed, using a non-structured line scale, with intensity descriptors at the end points (0, the absence of descriptor; 10, high intensity of descriptor). The room temperature was kept at 20 °C. Samples were presented in Petri dishes, marked with three-digit codes. The order of serving was determined by random permutation. Two-panel replicates were done on each sample. The response to each indicator was determined as the mean value of the panellist's responses.

2.4. Statistical analysis

The data were statistically analysed using SPSS for Windows version 15.0. (SPSS Inc., Chicago, IL). Mean values of the sensorial attributes, as

Table 1
Sensorial descriptors and their definition.

Attributes	[a]Cd	Description
Odour		
Intensity	Oi	Overall odour intensity.
Smoke	Osm	The smell of burnt wood smoke.
Toasted	Ots	The smell of toasted almonds.
Dried pepper	Op	Odour similar to ñora (a typical Spanish dried pepper, *Capsicum annuum* L.)
Fruity	Of	Reminiscence of fresh bell pepper.
Straw	Ost	Odour associated with dried plant materials, like straw.
Flavour		
Intensity	Fi	Overall flavour intensity.
Persistence	Fpe	An attribute associated with the time that the overall flavour is maintained.
Smoke	Fsm	Sensations associated with smoked flavour.
Dried pepper	Fp	Flavour similar to ñora (a typical Spanish dried pepper, *Capsicum annuum* L.).
Fruity	Ff	Reminiscent of fresh bell pepper.
Straw	Fst	Flavour similar to dried plant materials, like straw.

[a] Cd: Code of the descriptors for PCA analysis.